CONTRIBUTIONS TO THE LIFE HISTORIES OF PLANTS, NO. 8.

BY THOMAS MEEHAN.

EUPHRASIA OFFICINALIS.

Mr. Darwin, in his interesting work on "Cross and Self-fertilization of Flowers" (1877), places this pretty little plant in the list of those which have "become modified so as to insure self-fertilization." Some additional information on the subject makes it worth while to go over the whole matter again.

The flowers are so abundantly fertile that one would at once infer that it is self-fertilized, but the apparently strong proterogynous character of the flower leads to a suspicion that this impression is wrong. The curved style is projected beyond the corolla before the latter is fully expanded, appearing like a folded thread of silk, completely closing the mouth. The stigma at the end of the incurved portion is bent down onto or under the anthers which present it with pollen before the flower has fully expanded. So early is the flower fertilized that the pistil, having fulfilled its function, dies away almost immediately after the mouth of the corolla fully expands. The flower presents the remarkable phenomenon of a pistil dried up almost as soon as the corolla is fully open. It seems evident that the pistil matures long before the stamens, but the curvature of the style keeps the stigma in contact with the stamens so that it cannot escape fertilization. If the pistil were projected in a straight line, as is usual in flowers, it is more than likely that aid would be required in securing pollination. It does look as if the expression quoted from Darwin, that the flower had been modified to ensure self-fertilization, is in this instance literally correct.

NOTES ON GAURA AND ŒNOTHERA.

Although in a general way, flowers of some species of *Gaura* and allied genera are known to open toward evening, and with some suddenness, so far as I know, no details of the phenomenon have been recorded. Having plants of *Gaura biennis* and of *G. parviflora* within a hundred feet of each other, under nearly the same conditions, I spent a week previous to the 20th of August in closely watching them, with the view of noting any difference in the behavior of the two closely allied species.

Having come to look on those plants that are abundantly fruitful as self-fertilizers, I was at first struck with the exceptional fruit-

fulness of every flower in *Gaura parviflora.* On one spike examined, 148 flowers had bloomed, and each had produced a perfect capsule. Many more flowerbuds had yet to open. The result of the observations showed that the plant is absolutely a self-fertilizer. On every night of my observations the first blossoms commenced to open at 7.15 o'clock, and by 7.30 all had opened that would open on that evening. The expansion is so extremely sudden that it is only with great difficulty that the process can be observed. The eye can be taken for an instant from one flower to another alongside, and instantly back again, only to find that expansion has occurred. A good magnifier is necessary to see the process distinctly. On expansion the petals stop when at a right angle with the axis, but the sepals fly completely back on a line with the ovarium. Opening some flowers at 7 o'clock, no pollen is visible, but the anther cells are ruptured and abundantly pollen-covered at expansion. We may conclude that this act is simultaneous with the opening. The anthers are held to the stigma by the gelatinous pollen, except an occasional one that is held fast by the expanding petal or sepal, and drawn over, which also shows that the anther cells rupture at the time of expansion or a little before. As evening progresses the stamens draw their anthers more or less away from the stigmas, but they alone can fertilize the pistils. By a lamp, later in the evening, small night moths are found about the flowers, and some moth hairs on many of the glutinous stigmas show that the flowers have been visited by them. The flowers commence to fade at daylight, the stamens dropping first, then the pistil, and by 8 A. M. the petals wither, unless the day be cloudy, when they continue a little longer. The upper portion of the leaves of this species are vertical, the result apparently of a continuation of the coiling tendency longer than in some other plants, and without any physiological significance.

Gaura biennis.—In this species some open at 8 P. M.; all are open at 8.30 P. M., that are to expand that evening. They open by jerks. First there is a sudden flying apart of the sepals, just enough to show the pinkish-white petals, the openings being not more than two lines in width. After about three minutes another effort occurs, when both the sepals and petals are at right angles with the axis. After another rest of about three minutes the sepals fall back on the ovarium. An effort was made to encourage a flower to open earlier in the evening by separating the sepals

with a pen-knife, but it had no effect on the opening of the flower till the regular opening time arrived. The stamens are shorter than the style, so that at expansion the anthers are below the stigma. The pistil remains erect, and the stamens fall without the pollen coming in contact with the stigma, as far as I could trace. The pistils droop by morning, when the under surface of the compound stigma is usually found covered with pollen, as if it had dropped from the anthers. A large number of species of night moths attend the flowers during the night, and most of the flowers have moth hair on the stigmas. It seemed probable that insect aid had much to do with pollinating the flowers.

The lower portions of the spikes are infertile, and this adds suspicion that insects are necessary to aid in the work of fertilization, as they may not have been present or found the Gaura plants till many flowers had fallen, but nearly all the later flowers are fertile. Soon after daylight the stamens and style have withered, but the petals do not collapse till 8 or 9 o'clock, and if the day be cloudy, the petals will continue apparently fresh till noon.

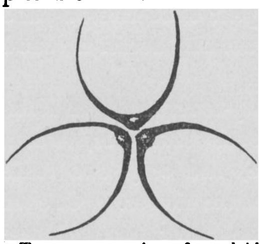
Aside from fixing the exact time and manner of the opening of the flowers of these two species, there is a peculiar interest in the fact that while the one is undoubtedly a strict self-fertilizer, its near neighbor seems to be in a great measure dependent on insect agency, and this remarkable difference is apparently due merely to the fact that, in comparison with the pistil, the stamens are a little longer in the one species than in the other.

Œnothera biennis.—I endeavored to ascertain the exact time and manner of the opening of the flowers of *Œnothera biennis*, but could not manage to catch it at the right moment. An interesting fact well worth recording, however, is that the anther cells burst when the bud is comparatively young, long before expansion, covering the stigma with the flower's own gelatinous pollen. The stigma is not receptive at this time, but the pollen remains until it is, thus insuring self-fertilization.

The Carpellary Structure of Nymphæa.

An abnormal flower of *Nymphœa odorata* from New Jersey, sent to me by Mrs. Edward S. Sayres, of Philadelphia, indicates the manner in which the carpels are formed. The place of the usual radiating stigmas was occupied by three petaloid processes, very suggestive of the

pistils of an Iris. These were recurved as in the annexed diagram, which shows a cross section of the three. From this it would appear that the ovarium is made up of a number of carpellary leaves of which the midribs form the axis. In the normal flower the compound ovary is usually from 12- to 24-celled, according to Gray's Genera; in this case but three carpels were attempted. In this genus the line between the various floral organs is very finely drawn. Petals, stamens, and the carpellary system with its pistils run closely into each other. Hence the numbers in each class of organs easily vary. It would not be wholly unexpected to meet with cases in this or allied genera where the flowers would have the pistils wholly aborted; that is, the plants might produce wholly staminate flowers.



Transverse section of petaloid carpels, replacing the normal gynœcium in *Nymphæa odorata.*

On the Sexual Characters of Rhus.

Exact botany suffers much from the want of care in the application of terms, especially illustrated in the use of the words hermaphrodite, diœcious, polygamous, and polygamo-diœcious, by different authors in connection with the genus *Rhus.* There is a section described as hermaphrodite, in which the mist tree of gardens, *Rhus cotinoides,* is placed. But I have shown that this species is truly diœcious.[1] Chapman, in his "Flora of the Southern United States," divides the North American species into two sections, one "Flowers polygamous," the other "Flowers diœcious." He places *Rhus copallina* in the former section, leaving the diœcious section to the poison Rhus, *R. venenata,* and *R. Toxicodendron.* Don, in the "Gardener's Dictionary," places *Rhus copallina* in the diœcious section, with the poison vines of Chapman, while Dr. Darlington, in "Flora Cestrica," styles all the species "polygamo-diœcious." As these terms are employed in the sectional characters, their use is perplexing to the student. After a careful examination, extending over some years, I have found no case in which an isolated plant produces seeds. The plants are all truly diœcious, and the terms hermaphrodite and polygamous applied to any Rhus are misleading, and should be abandoned. Often, isolated plants will be found in which the car-

[1] Proceedings of the American Association for the Advancement of Science, Vol. XXII, pp. 73–75.

pels appear perfect, but are hollow by reason of not having been fertilized. In some flowers the stamens appear antheriferous, and this fact has probably led to the belief in hermaphroditism, but I have never found one to be polliniferous.

Close inspection this season of some twenty-four plants of *Rhus copallina,* led to observations of a novel character, worth recording. There were twenty-two female, and only two male plants. There are three pistils in the female flower. One of these is larger and deeper colored than the other two. These two finally abort, only a single carpel reaches perfection. The brown papery anthers are devoid of pollen, and have either no filaments or very short ones. Between the staminate cycla and that forming the gynœcium, are glands, seemingly an undeveloped series of stamens. These exude a great abundance of sweet liquid, which attracts honey-bees and other insects in large numbers. I have counted twenty honey-bees at work at once on a single panicle, many of them falling victims to the soldier beetle, *Reduvius novenarius,* which finds the Rhus a fertile hunting ground.

The male flower is especially distinct from the female in having no honey glands. The highly polliniferous anthers are on five long exserted filaments. These filaments are erect, and the anthers approach, forming a sort of crown, as if to protect the pistils which are in a depauperate condition beneath. The profusion of golden pollen is very conspicuous in these male flowers. In the female flowers the sepals are ovate and spreading, while in the males they are lance-linear and recurved. The rachis and pedicels are more slender and longer than in the female.

Considering the abundance of pollen, it would seem almost certain that at some time or other pollen-gathering bees would visit the male flowers, but whenever I saw them at work, it was only on the female plants. The abundance of liquid from the floral glands seemed an inducement to greater exertion, and watching these creatures on *Rhus copallina,* gave me, for the first time, the impression that there were times when these ever industrious creatures make special effort.

The subject of the relation of insects to flowers naturally thrust itself on my attention during these observations. Sweet secretions in these flowers certainly can have no significance as a means of insect attraction for the purposes of cross-fertilization, or of fertilization of any character. Insects seem to serve no object of the

plant in any direction whatever, while the female plant has to depend on the wind for its fertilizing material.

The sap between the bark and the wood, both in this and in other species of *Rhus*, is very sweet and particularly abundant, and on the slightest scratch, courses down the branches; in gathering it insects almost fight each other. The little exuding through the glands seems the result of an effort to get rid of a superabundance, and without any special significance in the economy of the plant.

RUBUS CHAMÆMORUS.

Authors have variously characterized this plant. Thus, Don (1832) notes it as diœcious, Beck (1833) monœcious, while Michaux (1803) and Torrey (1826) leave the inference that it is hermaphrodite. Lightfoot, in "Flora Scotica" (1787), says, "This plant is diœcious above ground, but, according to a curious observation made by Dr. Solander, the roots of the male and the female unite together under the earth so as to render the plant truly monœcious." Dr. Gray (1867) regards the plant as diœcious. It did not matter so much, in the past generation, about special accuracy in these particulars, but in more recent times, when these questions enter largely into botanical philosophy, more accurate diagnoses are desirable. Specimens brought to me by botanical friends at Seal Harbor, Maine, show the plant to run extensively by underground stolons; one flowering branch with dried flowers producing no fruit, and another with berries from the same stolon, indicated that Solander was right in giving it a monœcious character without, however, the necessity of calling in underground grafting to account for the phenomena. The male "canes" appear to have been longer than the fruit-bearing ones. Dr. Gray, in the sixth edition of the "Manual," makes a subsection in which this species is placed, the flowers having a 5-lobed calyx. In all the specimens brought me each had but four lobes. Residents of Mt. Desert Island call the fruit "baked apple berries."

DALIBARDA REPENS.

No author gives the slightest hint of any irregularities in the flowers of *Dalibarda repens*, though its relative on the one side, *Rubus*, has a monœcious representative in *R. chamæmorus*, and on the other side in *Fragaria chilensis*, and often in *F. virginiana*.

Confined to my room, at Seal Harbor, Maine, in August of the present year, by temporary illness, good botanical friends, and espe-

cially Mr. John H. Redfield, brought me generously large amounts of fresh plants, their daily collections. One of these, which I had no subsequent opportunity to see growing, was *Dalibarda repens*. My observations are therefore, wholly from these few plants, though the facts have been subsequently confirmed by Mr. Redfield.[2]

The single flower on the four to five inch scape, was found wholly staminate, the stamens being very numerous. The scape branched at the base, having what we might term a pedicel of an inch or so in length, recurving and bearing small cleistogene buds. These were found to contain but five short stamens, and the anthers, polliniferous, pressed down on the stigmas. These bud-bearing pedicels grew into the rotten leaves beneath the foliage, and matured the seed vessels beneath the surface, just as many violets do, bringing to mind that Michaux's name of *D. violæoides*, was still more expressive than even that author supposed.

As many of these subterranean seed vessels were ripe, it shows that cleistogamy commences quite early in the season, how early has yet to be ascertained. The earliest ones, it would seem, must have the flower on the 5-inch scape perfect, as the descriptions given by authors, no doubt, were drawn from these, and are given as with all the floral organs perfect. My rough notes, made on the spot, say, "the female or fertile flowers, with becoming modesty, withdraw into privacy beneath the ground, while the foppish male flowers seem to have no office in life to perform but to make a show of themselves." It may be remarked here, that in many cases of plants bearing cleistogene and fertile flowers they at some time produce what are regarded as normally perfect flowers, and these are supposed to be for the purpose of enabling the plant to get a chance to bear cross-fertilized seed. But so many of these are wholly infertile, while this *Dalibarda* is absolutely masculine, that it would seem that the fact may be capable of some other explanation.

On Some Morphological Distinctions in the Genera of Ericaceæ.

The sub-orders of Ericaceæ divide naturally into the free or the adherent calyx with the ovary, but an examination of various members of the order indicates a suppression or multiplication of series

[2] As these pages are going to press, Mr. Redfield notes that Dr. Gray has recorded the finding of *Dalibarda repens* cleistogene by Mr. Pringle.

of organs, and the impressment of one set into the service of another to such a degree that the morphologist will find little in an original type to divide into sections. *Monotropa uniflora* represents a section where the calyx is free from the ovary. The ovarium is described as being 10-grooved, but it is evident that this grooving is the result of ten staminal scales which have become adherent with the ovarium. To describe the flower properly we might begin with the 5-carpellate ovary. Though the "stigma" is usually described as being single and funnel-form, it would seem that a strictly correct form of expression, from the morphological standpoint, would be that there were five stigmas, united by a thin membrane into a circular, web-like disk. In the flowers before me there are ten stamens, but these are certainly in two series of five each, one set rather larger than the other. The upper and larger series alternate with five of the scales, and press the anthers close up under the fine stigmatic portions on the edge of the disk, and in this way effectually secure self-fertilization. The next series of five are shorter, and always keep the anthers free from connection with the stigmas. Both series of stamens, however, have the hairy filaments curved in toward the ovarium as if they also would have become adherent scales if they had had a fair chance. At the base of the ten stamens, and alternate with them, are ten horn-like processes, evidently each alternate one being slightly smaller than the other, representing two series which we may term either abortive stamens or abortive petals, as suits best the morphological view. These, however, curve outward and downward instead of inward, and should possibly be classed with the corolliferous rather than the staminal system which, as above noted, possesses an incurved tendency. From the apex of these glands, however, a large quantity of sweet liquid exudes and they might be termed "nectaries," if there were any separate place for such organs in the morphological type. There are five petals and it is singular that three of these seem always to be twisted, folding over each other from right to left while one petal is usually backed by the two adjoining (imbricate) plates, the edges of these almost meeting behind the petal which they enclose. Outside of these we have the remains of five sepals, varying so much in size that occasionally but two can be recognized.

It will be seen that this conception, as fortified by observation, makes the flower far less of a departure from the usual types of Ericaceæ, and places the genus more in harmony with its fel-

lows. Comparing the points here made with specimens of *Gaylussacia dumosa* before me, the stigma may be seen to be disc-shaped, as in *Pyrola*, with, however, ten stigmatic points on the margin of the disc, indicating a 10-carpellary structure. The ten flat anthers press closely against the style, and can be safely taken as the analogues of the ten adherent scales through which the pistil seems to protrude in *Monotropa*.

Taking up now *Pyrola rotundifolia*, we find, in the earlier stages, such a wheel-shaped disc in the stigma as may be seen in *Monotropa*, but with age they advance beyond the membranous connective and thus give us the "5-rayed stigma" of authors.

If we now take up *Moneses uniflora*, the "ten stamens" are found to be in series. Two of these series consist of three stamens each, two series of but a single stamen each, but occasionally there are two stamens in each of the latter sets, which make the full complement of ten, and we see here the tendency to a suppression of parts is very strong.

The whole lesson teaches the morphological unity of type in the sections of Ericaceæ to a greater degree than usually supposed, and that the cohesion or freedom from cohesion of the various cycles comprising the theoretical foliar system is the chief governing influence in the formation of genera in the order.

Vitality of Seeds. Lysimachia atropurpurea.

That seeds will live long in the earth in many cases is a general belief, but too frequently the facts presented are open to objection. Direct and incontestible evidence is still desirable. I am accustomed to sow seeds for the purpose of botanical examination and for specimens. In 1886 I had a few plants from seeds of the European annual, *Lysimachia atropurpurea*. After a study of the plant no further seeds were collected. In the winter following, this part of my garden was given up to building operations, and the earth filled in, several feet in depth, over where the Lysimachia grew, and on this large evergreens were planted. Last spring one of these evergreens was removed and a hole left, nearly two feet deep. In the bottom of this hole a Lysimachia plant came up this summer. There can be no other explanation than that the seeds had been there six years, as no Lysimachia has been growing in my garden since.

For some days prior to August 22, I took the plant under close examination from day to day. That plants do not grow continu-

ously but advance from stage to stage by leaps—making considerable rests between the stages—is well illustrated by the flowers of this plant. After the flower bud has reached a stage ready for expansion, it rests for a day but the style continues to grow and pushes through the closed flower bud to the extent of about two lines. Then it rests, and the corolla opens and assumes an erect campanulate form. The stamens grow as the petals lengthen, but continue growing for a day after the corolla is at rest, continuing till they exceed the style, the anthers forming a close circle just above the stigma, when they discharge their pollen over it. As every flower is fertile, and the plant produces seeds profusely, I surmised that the flowers must self-pollinate but the advance of the pistil, with its evidently receptive stigma, so long before the maturity of the anthers, seemed theoretically against this view. In a large area of these flowers, where some plants in bloom would mature in advance of the others, insects might convey the gelatinous pollen to the exposed pistils on other plants. In this one specimen, however, there were no insect visitors observed except an occasional sand wasp, and the effect was only to help the stigma to its own pollen. This plant was certainly self-fertile, though the conditions seem to be such that it might be cross-fertilized under favorable circumstances.

Campanula rotundifolia.

A large branch of specimens, placed in water for a week, presented some remarkable variations. The lobes in most instances were about one-fourth the depth of the campanulate corolla, in some instances one-third. In one case the corollas on the stem were cut to fully one-half their length, and the lobes spread so that with a little more effort the corollas would have been rotate! The flowers of this species of *Campanula* are centrifugal, the terminal one opening first. A number of these terminal flowers were 10-lobed with ten stamens, still more with six lobes and six stamens, but the majority were normal with five lobes and five stamens. In one flower with five lobes, the five stamens had been transformed to petals, and it is worthy of note that these five were separate and not united into a monopetalous corolla similar to the outer series. On the same stalk, another flower had two of the stamens somewhat petaloid instead of antheriferous. Two other flowers on the same stalk were normal.

Although the flowers of *Campanula rotundifolia* are classed as proterandrous, the pollen is not ejected from the anther cells till after the corolla has opened and the hairy pistil has been developed considerably beyond the line of the anthers, though most of the genus seem to discharge their pollen while still in the bud. The stamens wither soon after the anthers have discharged their pollen. In the flowers in this large branch the stigmas do not expand till the fourth day after flowering. In the quiet atmosphere of the room and in the absence of all insects that are usually considered aids in fertilization, there seems to be no pollen on the stigmatic surfaces, but capsules are all enlarging, and the young seeds swelling as if the fertilization of the flowers had been perfected. It is difficult to believe that in some manner fertilization has not taken place. Only the full ripening of the seed could positively prove this point. Unfortunately I had not the opportunity to test it.

The variation of the color in the flowers of this branch may be noted. During the week that I had them under observation, there may have been between two and three hundred flowers. Some were nearly white, others of a rosy purple, the majority blue. The observations were concluded on the 15th of July.

Cornus canadensis.

Some of the exotic species of *Cornus* are diœcious, but there is no record of diœcism in any of the American species. The plant is very common on Mt. Desert Island. Near Northeast Harbor I spent several hours, July 27th, examining these plants particularly, amongst other things, and would frequently find large patches that were evidently the production of several years by underground stolons, entirely barren. Other patches would have a single berry in the central portion of the cyme and all the others barren. Other patches were abundantly prolific. It is a safe inference that some plants are monœcious and others wholly diœcious.

As it is well understood, the leaves are really in opposite pairs, the verticil being formed by the suppression of the internodes and axillary buds. One specimen was found in which two axillary buds had produced branches, and these two again produced each two more from their apices. These four branches were terminated by four heads of flowers, each with its four milk-white bracts which in the midst of so many companion plants with numerous red berries had a unique effect.

As in the great dogwood, *Cornus florida*, some of the bracts are shaded from light-rose to deep pink, as appeared from some belated flowering plants.

The so-called "bracts" of these species of *Cornus*, as I have noted elsewhere, are not true bracts but merely simulate them. They are flower bud scales which have taken on renewed growth, carrying along the earlier formation which, during the winter, acted as a bud scale and which, in the spring season, gives the dark obtuse apex to the "bract."

ARALIA HISPIDA.

An interesting feature in many plants is that while the inflorescence, as a whole, may be centripetal the flowers themselves are centrifugal. *Aralia hispida* is a good illustration. While the terminal umbel is the first to flower, the flowers themselves in each umbel are centrifugal.

Of special interest in this species is the fact that while all the male flowers have but five stamens, fully one-fourth of the female flowers have six carpels.

LUZULA CAMPESTRIS.

The appendages at the base of the seeds in some species of *Luzula* are well known. It occurred to me to endeavor to ascertain their special function. No theoretical conception as to their function or place in the economy of plant life could be satisfactorily formed. A novel point seemed to be that long after the flower stalk had become dry, and the valves of the capsules expanded, the seeds were held in place by the appendage, hanging loosely from side to side as the capsule might be turned about. While so many plants have arrangements for projecting seeds from the capsules, it seemed remarkable that this should be specialized to retain them.

CAKILE AMERICANA.

The flowers being unexceptionally fertile led me to infer that they were self-pollinate. Examining a large number at Atlantic City in the middle of June, I found this to be the case. The anthers press against the stigma and cover it with their own pollen before the bud expands. A remarkable feature in the Atlantic City flowers is the comparatively small size of the petals, and in a large number of flowers only a single pair of petals are produced, the flowers losing in these cases their cruciferous form. At Seal Harbor, Maine

a month later, no bipetalous flowers were noticed, but the same fertilization in the unexpanded flower occurred. The Maine plants have a more zigzag habit of growth, and the leaves are more dentate (in many cases pinnatifid), than in the Atlantic City plants.

Hypericum ellipticum.

Generic characters, like those of species, are often found running so close together that it is difficult to draw a dividing line. No one would question the propriety of separating *Ascyrum* and *Hypericum*: *Ascyrum*, "sepals four, very unequal;" *Hypericum*, "sepals five, somewhat equal." In this species there are really but four sepals, but a minute bract does duty as a fifth sepal. The sepals are almost as unequal as those of any species of *Ascyrum* could be.

Trifolium hybridum.

So much has been said of the relations between insects and the flowers of clover that more would seem superfluous, but of *Trifolium hybridum*, the Alsike or Swedish clover, few observations have been specially recorded. Of late years this species has become common on Mt. Desert Island, at least it is very common about Seal Harbor, where the unusual beauty and fragrance of the flowers press it closely on our attention. Observing that every flower seemed fertile, I anticipated self-fertilization, and found that this was the case. In the unopened bud, just before the expansion of the petals, the stamens and pistils are of equal length. The anthers press closely against the stigmatic surface of the pistil and discharge the pollen therein before the flower opens. After expansion the flattened keel presses and keeps pressed together the stamens and pistil, preventing any exposure at any time. The stamens and pistil remain thus entombed through life, dying eventually in each other's arms. If an insect or the thumb nail be pressed against the base of the keel the pistil and stamens are set free, but only to expose the pollen-covered stigma. Many species of plants have their stamens and pistils so arranged that, though close fertilization is the rule, the use of foreign pollen is not an absolute impossibility, though, when we consider how few seeds of a crop ever get a chance to grow again, the physiological value of an occasional cross on a seed which has small chance of ever growing is not apparent. But even this chance is lost to this species of clover as found growing here in July, for the abundant fertility is certainly due to self-pollination, and cross-fertilization is wholly out of the question. Bees do not

seem abundant in this locality. Only a small species of bumble-bee was observed at any time, and none visiting these clover flowers.

Lathyrus maritimus.

I have pointed out in previous contributions that when leaf-growth is arrested to form bud-scales, sepals, or petals, the laminal portion or blade usually becomes effete, and it is usually the stipular portions or dilated bases of the leaves that are transformed to do the protective work. In *Lathyrus maritimus* this is particularly obvious, the large stipules being fully formed, and acting as protectors of the young buds, even before the rest of the leaf-blade is developed. If no leaf-blade proper were produced at all, and the axial growth arrested, these stipules would be reduced, and then properly be termed bud scales.

Many species of *Lathyrus* are on record as being self-fertilizers. No note seems to have been made of *L. maritimus.* At Seal Harbor every flower seemed fertile, indicating self-fertilization. Unless the flowers are disturbed the stamens and pistil remain to the last wholly enclosed by the keel. When, however, a visiting insect presses the keel downward, the upper portion of the style projects considerably beyond the apex of the keel, but the stamens remain wholly included. An insect in search of honey, covered with pollen beneath, might then easily cross-fertilize the flowers, but as the anthers seem never exposed in these flowers, so far as I could ascertain, there is no pollen collected by the bee for transmission to another flower. A peculiarity of this species seems to be that the vexillum presses down and clasps the keel in the earlier stages of anthesis, preventing the ingress of insects, and it is only in the later stages, after self-fertilization has been fully accomplished, that the vexillum becomes erect, and the entrance of insects permitted. This species will have to be classed with those already admitted to be absolutely self-fertile.

Lonicera cœrulea.

It is many years since I handed to our good friend Professor Asa Gray, some evidence, as I supposed, questioning the soundness of the belief that leaf blade has its primary origin at the node from which it seems to spring. The sententious reply I shall never forget, "nevertheless, I maintain that decurrence is decurrence." For all the overshadowing eminence of this great and good man facts continually come before me that seem inexplicable under the

accepted hypothesis. It seems to me that the origin of leaf-blade must be at some indefinite place below the point of departure from the axis, and that "decurrence" is simply the effect of an irregular meeting of the edges of the clasping leaves. In the case of plants which have the young branches square or flat-stemmed, but round in their after stages, it would seem that the only way of accounting for it is by conceiving the union of the edges of the blades as they clasp the stem.

An examination of some specimens of *Lonicera cœrulea* brought me at Seal Harbor by Mr. Redfield July 22nd, clearly demonstrated that this was the case. The growth of the present year is square-stemmed. In cutting the stems across, mid-way between the nodes, the costa of superposing leaf is clearly seen. The scales, at the termination of the season's growth suggest this behavior also. They are boat-shaped, evidently formed from a theoretically dilated base, and meet by their edges. Later on, incipient leaf-blades may be seen starting from their terminal points. That with a little modification these scales could have been elongated, become united at the edges, closely clasp the real bark, and then by the formation of leaf-blade diverge at the node, seems so plausible that there is little doubt that this has been the process during the vigorous growing season.

I have shown elsewhere that the rifting of bark is not a mechanical operation due to the growth expansion of the stem, but that provision is made in true bark for this rifting by the formation of suber cells which develop after a certain number of years have elapsed, and which disintegrate the bark and thus permit the expansion of the wood beneath. Every ligneous plant has, by a specific growth of these suber cells, its own special manner of providing for the opening of its bark. In *Lonicera cœrulea* and similar plants with square stems, or decurrent leaves on the young growth, there are none of the suber cells on the external epiderm which truly formed bark should have. In the specimens brought me the "square" or external layer had not been thrown off, and by a little help from the knife, I was able to detach the whole from a branched specimen, just as if it had been a paper mask. This epiderm, having no cork cells, has to burst by drying or by the expansion of the woody axis, and the rupture is down the weakest line of union, namely, where I have conceived the hypothetical union of the edges to have been. The square stem is then changed to a round one, the epiderm of

which is strewn with minute ovoid nests of cork cells. From the well ascertained facts as to the manner of bark formation the outer epiderm could not possibly have been formed in the same manner as the hypoderm, namely, by the differentiation of the horizontal cells, but could only have originated from an independent exogenous growth, such as a supposititious enclosure by a clasping leaf-blade could produce. Aside from these considerations the continuity of the nerves in this intra-nodal sheath with the nerves of the leaf-blade indicated, clearly shows the identity of their origin.

It may be said in brief that while plants, generally, in their first year's growth, have only two separate systems—wood and a single layer of bark—a section of *Lonicera cœrulea*, and plants constructed on a similar plan, have three, the outer layer of which, by the absence of suber cells and other characteristics, clearly is not true bark. There seems to me little doubt but square-stemmed annual growths or the appearance of decurrence on growing stems, is due to the fact that the leaves have really originated below the point from which they seem to emerge, and that the angularity or decurrence is due to the more or less imperfect meeting of the edges of these leaves when clasping the stem.

RAPHANUS SATIVUS.

The garden radish is admittedly self-fertile, but noting on the 14th of August an unusually large number of the cabbage butterfly (*Pieris rapæ*), as well as several other Lepidoptera, about them, I was led to make an extended observation with some novel results. There were a large number of plants in the row under observation, and the remarkable difference in fertility in the different plants, first attracted my attention. In some cases, possibly three-fourths of the flowers had produced seed vessels, in others, about half, while some plants had only a few scattered pods. As the plants were still flowering freely, good opportunity was afforded to see how far sexual conditions might influence these several characteristics. There were found some remarkable morphological peculiarities worth noting.

In one flower one of the basal glands had developed to a perfect pistil, which was half the length of the normal one! As there have been different views of the nature of these glands, may we not regard them as undeveloped axillary buds? In this flower instead of four long and two short, the whole six stamens were of equal length.

Another flower had but three long stamens, and these a little longer than the pistil at this stage of blossoming. Of course in this,

as in many cruciferæ, the capsule elongates after petals and stamens fall. The two short stamens were normal.

Another flower, in addition to the normal six stamens had two of the petals antheriferous. There was but a very slight attempt at petal bearing. It is worthy of note that the insertion of these antheriferous petals was much more nearly opposite the glands than usual, indicating that a disturbance of the spiral growth co-existed with the abnormal condition of the petals.

Three flowers had a third gland. In one flower the third gland was only half the size, but in other respects similar to the others; in the other two the extra glands were long and horn-like, as if they were partially developed pistils.

Another flower had three long and three short stamens. Two flowers were found with three series of stamens, each series of two, of different length. In these the upper pair curved inward, touching the stigma by the upper portion, the anthers, however, recurving from the pistil.

A flower with four glands was another surprise. One of the two normal ones was unusually large and 5-lobed at the apex. The two extra glands are between the shorter pair of filaments.

Another had the four long filaments colored like the petals, while the filaments of the two short were white and transparent.

It is well to note that while the insertion of the short stamens is always under the normal glands, the extra glands are between the pairs, indicating that they belong to a distinct cycle from the other two.

Examining the flower-bud while comparatively young, a unicellular transparent hair is found at the apex of each sepal, which is early deciduous, leaving a bulb-like base, which might easily become a "gland" under some morphological change.

The upper portions of the filaments connive, and might without close examination be regarded as united. It may be noted that on the opening of the flower the lower portion of the sepals separate first, leaving the upper portions to connive to the last. In some flowers the sepals remain united to the last, and are monosepalous.

In a number of plants which had only a few seed pods on them, the anthers were evidently barren. These plants have had these few fertile flowers pollenized by insects. In other plants the four long stamens would be barren, while the two short stamens would have abundant pollen.

The conclusion left on the mind of the observer was that some plants of the radish were arranged for self-fertilization, and others required the intervention of insects, but that this so-called "arrangement" was brought about through various phases of nutrition affecting the growth of different portions of the plant, and in which special arrangements for fertilization had no primary place.

On the Nature of the Verrucæ in Some Convolvulaceæ.

The stems of some Convolvulaceæ, notably the one in common cultivation as "Moon-flower" (*Calonyction speciosum* Choisy, *Ipomœa Bona nox* Linnæus), are verrucose. No explanation of the nature or functions of these warty processes has ever been given, so far as the knowledge of the writer extends. Horticulturists who have given any thought to the matter have regarded them in the light of attempts at root formation or as somewhat akin to the rootlets along the branches of ivy; but these have been only passing impressions. A critical examination, however, shows that they have no central system, as true rootlets have, nor have they a root-cap, as we find on genuine fibres.

It occurred to me to note the behavior of *Cuscuta*, when growing where it could not readily find a host plant. It produces haustoria ready to fasten on its victim when the opportunity might offer. The structure of these processes and those of *Calonyction* seem identical. As it must be conceded that *Cuscuta* is a genus of degenerate Convolvulaceæ, or rather a genus of plants that has come in the course of ages to be able to live on other plants, it does not seem improbable that these seeming excrescences on the *Calonyction* may be incipient haustoria, and that in the future other Convolvulaceæ besides *Cuscuta* may become parasitic. It must be said, however, that in many examinations I have made where these supposititious haustoria have been brought into close contact with other growing vegetation to such an extent, in some instances, as not to afford room for the usual longitudinal development, the excrescences have become flattened rather than make any attempt to penetrate the tissue of the approximating plant. This, however, may not militate against the supposition that these warty excrescences are incipient haustoria, unless the proposition that in plants environment, or more properly, perhaps, environment to a great extent, is the leading factor in the evolution of characteristic forms. Such a proposition, to my mind, implies that the change in form

should be responsive at once to the force that induced it. One can scarcely imagine a change in form to occur in a plant, responsive to irritation received from external causes by its ancestors hundreds, perhaps thousands, of generations previous. But if we take the succession of forms we know to have occurred, and know to have been evolved from closely related forms, as following in obedience to some law of growth as yet hidden from us, we can have no difficulty in suspecting that when the fulness of time shall arrive these analogues of haustoria will have full parasitic functions.

POLYGONUM CILINODE.

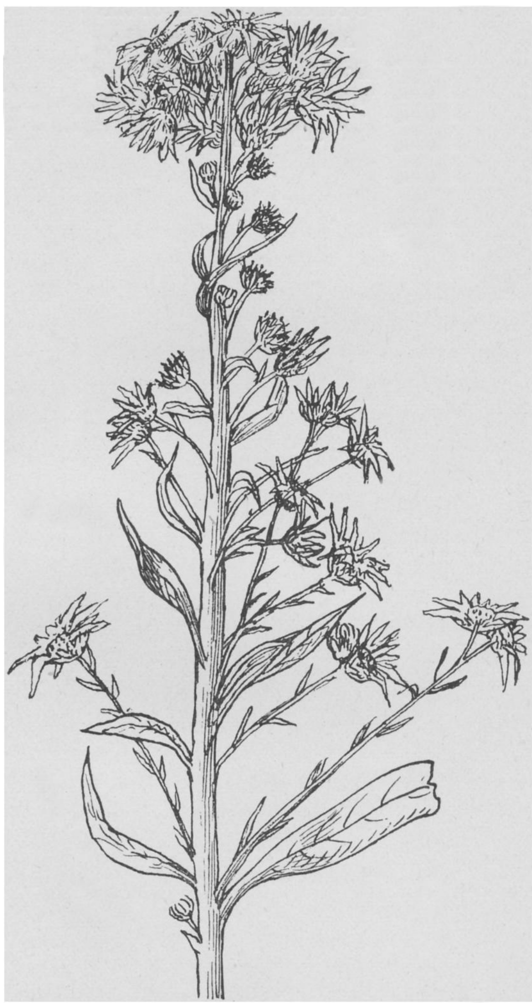
In a few instances, by no means common, I found July 12th at Seal Harbor, Mt. Desert Island, branches of *Polygonum cilinode,* which instead of being climbing were sarmentose, and, bending over, had rooted at the tip and formed a large terminal bud as we find in some species of *Rubus.* Many were found of a sarmentose or trailing habit, with no disposition to climb, though the facilities for climbing were within reach. In among the ramifications of the roots of these rooting tips were numerous cleistogene flowers, perfecting sometimes wholly underground. The flowers in the climbing branches are of two kinds as I have noted in other Polygonums, one always closed and fertile, the other open, apparently perfect in all respects, but barren. The inflorescence is formed of continuously branching axillary buds, and the only check to a further continuance of growth, seems to be exhaustion. The growth ends with depauperate buds. The species is evidently on the border line evolutionarily speaking between the merely upright and the climbing species.

ASTER TATARICA.

This Asiatic species exhibits in its inflorescence a curious mixture of characters separate in other species. The upper portion of the panicle is corymbose and comprises about a dozen flowers, which are centripetal, the central flower opening first. The flowers are quite gay with their numerous violet-colored rays. The lower flowers on the outer branches of the corymb, are, however, rayless; below this corymb is a conical panicle of a foot or more in length. The lower branches of this panicle extend six inches or more, and these lateral branches gradually shorten till they are scarcely an inch long. These branches are all centripetal in their growth from the central axis, but the flowers are centrifugal. In all the upper flowers,

those on the shorter branches of the panicle are discoid, as are the lateral ones on the branchlets.

The explanation seems to involve the question of rhythmic growth. Rest had been nearly reached at the point represented by the



apex of the cone, when the new flow of growth resulted in the terminal corymb.

To form the centripetal character of the inflorescence the axillary buds remain at rest until the branch has reached its final length,

when the growth wave returns, starting each bud again to development in this reflex action. As it is the lower and more slender pedicelled flowers which are discoid, nutrition has evidently determined the absence of rays, but whether this point was decided during the upward or the reflex movement of the growth-wave could not be determined, though the former seems the most probable.

The annexed figure from the dried specimen on the table shows the conical growth of the panicle almost to a rest, and the subsequent resumption of active growth to form the terminal corymb.